

Serial No. 10/536,760  
Atty. Doc. No. 2002P19496WOUS

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Amendments To Claims:

Please amend the claims as shown.

1 - 14 (canceled)

15. (currently amended) A method for designing a technical system, including state variables and diagnostic variables that depend on the state variables, comprising:

specifying the technical system by a system of equations and with the state variables being the solutions of the system of equations;

analyzing a measurement park, incorporating a first measured variable and the first measured variable is measured in the technical system with a prescribed accuracy and depend on the state variables;

measuring a second measured variable, which depends on the state variables, in the technical system with a predetermined accuracy;

determining sensitivity variables for the first measured variable and/or the second sensitivity variable for the second measured variable;

determining the magnitude of the influence which a change in the accuracy of measurement of the first measured variable has at least one selected parameter to determine the first sensitivity variable, and to determine the second sensitivity variable, a determination is made of the magnitude of the influence which the measurement of the second measured variable has at least one selected parameter;

changing the measurement park to produce an amended measurement park, the changing depending on the first and/or second sensitivity variable, in such a way that the accuracy of the first measured variable is changed and/or the first measured variable is taken out of the measurement park and/or the second measured variable is added into the measurement park; and

outputting a signal indicative of the using an amended measurement park for performing at least one of the following to design the technical system: selecting which respective state variables and/or diagnostic variables of the technical system to measure in designing the technical system, and determining respective measurement accuracies for state variables and/or diagnostic variables of the technical system.

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16. (previously presented) The method in accordance with claim 15, wherein the accuracy of the first measured variable is increased if the first sensitivity variable for this measured variable lies within a predefined value range and/or the first measured variable is taken out of the measurement park if the first sensitivity variable for this measured variable lies within a predefined value range and/or the second measured variable is added into the measurement park if the second sensitivity variable for this measured variable lies within a predefined value range.

17. (previously presented) The method in accordance with claim 16, wherein the technical system is described by a system of equations  $H(x) = (H_1(x), \dots, H_m(x)) = 0$ , where  $x = (x_1, \dots, x_n)$  is a vector in which the components are the state variables  $x_i$ .

18. (previously presented) The method in accordance with claim 17, wherein the following matrices are calculated: a matrix  $N$ , which spans the null space of the Jacobian matrix of  $H$ , a matrix  $W$ , such that  $W^T \cdot W$  is the inverse of the covariance matrix of the first measured variables  $y_i = b_i(x)$ , where the entries in the covariance matrix are the covariances  $\sigma_{ij}^2 = E((y_i - E(y_i))(y_j - E(y_j)))$ , where  $E(y)$  is the expected value of  $y$ , a matrix  $M$  which is the pseudoinverse matrix of  $A = W \cdot D_b \cdot N$ , where  $D_b$  is the Jacobian matrix of the first measured variables  $y_i = b_i(x)$ .

19. (previously presented) The method in accordance with claim 18, wherein at least one of the selected parameters is a selected state variable which can be determined via the first measured variables, one or more of the first sensitivity variables  $\Phi_{y_j x_i}$  represents in each case the ratio of the change in accuracy  $\Delta \sigma_{ij}^2 / x_i = \Delta E((x_i - E(x_i))^2) / x_i$  of the selected state variable  $x_i$  to the change in accuracy  $\Delta \sigma_{ij}^2 / y_j = \Delta E((y_j - E(y_j))^2) / y_j$  of a first measured variable  $y_j$ , the first sensitivity variables are determined from the following formula:

$$\Phi_{y_j x_i} = \frac{\sigma_{ij}^2}{r_{ij} \cdot \sigma_{jj}^2}$$

where  $r_{ij}$  is the element in the  $i^{\text{th}}$  line and the  $j^{\text{th}}$  column of the matrix  $N \cdot M \cdot W$ .

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20. (previously presented) The method in accordance with claim 19, wherein one of the selected parameters is a selected diagnostic variable which can be determined via the first measured variables, a matrix  $Dd$  is determined, this being the Jacobian matrix of the diagnostic variables  $d_i = d_i(x)$ , one or more of the first sensitivity variables  $\Phi_{y_j d_n}$  represents in each case the ratio of the change in accuracy  $\Delta \sigma_{nn}^2 / d_n = \Delta E((d_n - E(d_n))^2) / d_n$  of the selected diagnostic variable  $d_n$  to the change in accuracy  $\Delta \sigma_{jj}^2 / y_j = \Delta E((y_j - E(y_j))^2) / y_j$  of a first measured variable  $y_j$ , the first sensitivity variables are determined by the following formula:

$$\Phi_{y_j d_n} = \frac{\sigma_{jj}^2}{s_{nj}^2} \cdot \sigma_{nn}^2$$

where  $s_{nj}$  is the element in the  $n^{\text{th}}$  line and the  $j^{\text{th}}$  column of  $Dd \cdot N \cdot M \cdot W$ .

21. (previously presented) The method in accordance with claim 20, wherein at least one of the selected parameters is a selected state variable which can be determined via the first measured variables, one or more of the second sensitivity variables represents, in each case, the variance  $\sigma_{k \rightarrow x_l}^2$  of the selected state variable  $x_l$  when a second measured variable, the value of which is a state variable  $x_k$  with the variance  $\sigma_k$ , is being added to the measurement park, the second sensitivity variables are determined by the following formula:

$$\sigma_{k \rightarrow x_l}^2 = m_j^T \cdot m_l - \frac{(m_k^T \cdot m_l)^2}{\sigma_k^2 + m_k^T \cdot m_k}$$

where  $m_i$  is the  $i^{\text{th}}$  column of the matrix  $M^T \cdot N$ .

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22. (previously presented) The method in accordance with claim 21, wherein at least one of the selected parameters is a selected diagnostic variable which can be determined via the first measured variables, a matrix  $Dd$ , which is the Jacobian matrix of the diagnostic variables  $d_i = d_i(x)$ , is determined, one or more of the second sensitivity variables represents, in each case, the variance  $\sigma_{k \rightarrow d_n}^2$  of the selected diagnostic variable  $d_n$  when a second measured variable, the value of which is a state variable  $x_k$  which has a variance  $\sigma_k$ , is being added to the measurement park, the second sensitivity variables are determined by the following formula:

$$\sigma_{k \rightarrow d_n}^2 = q_n^T \cdot q_n - \frac{(m_k^T \cdot q_n)^2}{\sigma_k^2 + m_k^T \cdot m_k}$$

where  $m_i$  is the  $i^{\text{th}}$  column of the matrix  $M^T \cdot N^T$ , and  $q_n$  is the  $n^{\text{th}}$  column of the matrix and  $M^T \cdot N^T \cdot Dd^T$ .

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23. (previously presented) The method in accordance claim 22, wherein at least one of the selected parameters is a selected state variable which cannot be determined via the first measured variables, a matrix  $P$ , which is the orthogonal projection onto the null space of  $A$ , is determined, a second measured variable is determined, the value of which is a state variable  $x_k$ , and which is to be added into the measurement park so that the selected state variable can be uniquely determined, one of the second sensitivity variables represents the variance  $\sigma_{k \rightarrow x_1}^2$  of the selected state variable when the second measured variable  $x_k$  which has been determined, and which has the variance  $\sigma_k$ , is being added to the measurement park, the second sensitivity variable is determined by the following formula:

$$\sigma_{k \rightarrow x_1}^2 = \sigma_k^2 \cdot \frac{\|p\|^2}{\|p_k\|^2} + \frac{\|m_1 - m_k\|^2}{\|p_k\|^2},$$

with  $p = Pn_l$ , where  $n_l$  is the  $l^{\text{th}}$  column of the matrix  $N^T$ , and  $m_l$  is the  $i^{\text{th}}$  column of the matrix  $M^T \cdot N^T$  and  $p_k$  is the  $k^{\text{th}}$  column of the matrix  $P \cdot N^T$ .

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24. (previously presented) The method in accordance with claim 23, wherein at least one of the selected parameters is a selected diagnostic variable which cannot be determined via the first measured variables, a matrix  $Dd$ , which is the Jacobian matrix of the diagnostic variables  $d_i = d_i(x)$ , is determined, a matrix  $P$ , which is the orthogonal projection onto the null space of  $A$ , is determined, a second measured variable is determined, the value of which is a state variable  $x_k$ , and which is to be added into the measurement park so that the selected state variable can be uniquely determined, one of the second sensitivity variables represents the variance  $\sigma_{k \rightarrow d_n}^2$  of the selected diagnostic variable  $d_n$  when the second measured variable  $x_k$  which has been determined, and which has the variance  $\sigma_k$ , is being added into the measurement park, the second sensitivity variable is determined by the following formula:

$$\sigma_{k \rightarrow d_n}^2 = \sigma_k^2 \cdot \frac{\|p\|^2}{\|p_k\|^2} + \frac{\|M^T \cdot c_n - m_k\|^2}{\|p_k\|^2},$$

with  $p = Pc_n$ , where  $c_n$  is the  $n^{\text{th}}$  column of the matrix  $N^T \cdot Dd^T$ ,  $m_k$  is the  $k^{\text{th}}$  column of the matrix  $M^T \cdot N^T$  and  $p_k$  is the  $k^{\text{th}}$  column of the matrix  $P \cdot N^T$ .

25. (previously presented) The method in accordance with claim 24, wherein the matrix  $P \cdot N^T$  is searched for the column such that  $p$  is a linear function of this column, where the index  $k$  of this column specifies that the second measurement value  $x_k$  is to be added into the measurement park so that the selected parameter can be uniquely determined.

26. (previously presented) The method in accordance with claim 25, wherein the standard deviation  $\sigma_k$  of the second measured variable is 1% of the value of the second measured variable.

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27. (currently amended) A device for analyzing a technical system, comprising:

a storage medium;

a computer program stored on the storage medium, wherein the computer program comprises computer-readable code comprising: ~~is executed to accomplish the following~~ method;

a software module for specifying the technical system by a system of equations and a plurality of state variables being the solutions of the system of equations;

a software module for analyzing a measurement park, incorporating a first measured variable and the first measured variable is measured in the technical system with a prescribed accuracy and depends on the state variables;

a software module for measuring a second measured variable, which depends on the state variables, in the technical system with a predetermined accuracy;

a software module for determining sensitivity variables for the first measured variable and/or the second sensitivity variable for the second measured variable;

a software module for determining the magnitude of the influence which a change in the accuracy of measurement of the first measured variable has at least one selected parameter to determine the first sensitivity variable, and to determine the second sensitivity variable, a determination is made of the magnitude of the influence which the measurement of the second measured variable has at least one selected parameter;

a software module for changing the measurement park to produce an amended measurement park, said changing depending on the first and/or second sensitivity variable, in such a way that the accuracy of the first measured variable is changed and/or the first measured variable is taken out of the measurement park and/or the second measured variable is added into the measurement park; and

a software module for outputting a signal indicative of the using an amended measurement park for performing at least one of the following to design the technical system: selecting which respective state variables and/or diagnostic variables of the technical system to measure in designing the technical system, and determining respective measurement accuracies for state variables and/or diagnostic variables of the technical system.

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28. (currently amended) The ~~method~~device in accordance with claim 27, wherein the accuracy of the first measured variable is increased if the first sensitivity variable for this measured variable lies within a predefined value range and/or the first measured variable is taken out of the measurement park if the first sensitivity variable for this measured variable lies within a predefined value range and/or the second measured variable is added into the measurement park if the second sensitivity variable for this measured variable lies within a predefined value range.

29. (currently amended) The ~~method~~device in accordance with claim 28, wherein the technical system is described by a system of equations  $H(x) = (H_1(x), \dots, H_m(x)) = 0$ , where  $x = (x_1, \dots, x_n)$  is a vector in which the components are the state variables  $x_i$ .

30. (currently amended) The ~~method~~device in accordance with claim 29, wherein the following matrices are calculated: a matrix  $N$ , which spans the null space of the Jacobian matrix of  $H$ , a matrix  $W$ , such that  $W^T \cdot W$  is the inverse of the covariance matrix of the first measured variables  $y_i = b_i(x)$ , where the entries in the covariance matrix are the covariances  $\sigma_{ij}^2 = E((y_i - E(y_i))(y_j - E(y_j)))$ , where  $E(y)$  is the expected value of  $y$ , a matrix  $M$  which is the pseudoinverse matrix of  $A = W \cdot Db \cdot N$ , where  $Db$  is the Jacobian matrix of the first measured variables  $y_i = b_i(x)$ .